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High-level simulators in emergency department education: thoughts from the trainers' perspective

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What I read I forget
What I see I remember
What I do I understand

The use of manikins in emergency department medical education is well established. Early models enabled training in hands-on cardiopulmonary resuscitation. Later improvements in manikin technology provided the realistic simulation of intubation and defibrillation.

The educational advantages of realistic low-level simulators in scenario-based teaching have been previously described[1] (box 1). Indeed, they have a key role in adult and paediatric life support group courses. However, the realism in each scenario is limited by the technology. The trainee's need for a progress report (''what's the patient doing now?'') is familiar to seasoned instructors—skilled facilitation is essential.

But what if the technology allowed the manikin to breathe for itself? What if it had palpable pulses (or did not)? What if the instructor could control the respiratory rate, oxygen saturation and blood pressure in addition to heart rate and rhythm? What if the manikin could actually speak? And what if the model could physiologically respond automatically and appropriately to any given intravenous agent? Could you then not remove the facilitator completely from the room, allowing the trainee to totally engage in the scenario?

In this paper, we describe and compare the two types of high-level simulators currently in use in the UK. We give an account of our 2-year experience in educating trainees at the Bristol Medical Simulation Centre, Bristol, UK. We report on how close current high-level simulators are to a proposed ideal for scenario-based teaching—the remote-facilitator run scenario. Finally, we outline other current educational uses of simulators in the emergency department setting and hint at future roles.

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METHODS AND MATERIALS

A typical scenario

The candidate is called into the simulated resuscitation room by a telephone or tannoy call ''registrar to resus''. The call is made by a staff nurse who presents a 12-lead electrocardiogram (ECG) to the trainee on arrival. The patient is a 64-year-old man with chest pain suggestive of ischaemic heart disease. The patient is gowned and receiving 2 l of oxygen via a mask. He is visibly tachypnoeic, displays eye opening and is talking. His oxygen saturation, heart rhythm and blood pressure are continuously displayed on a monitor. The nurse reports that the paramedics have sited a cannula, and given the patient aspirin and glyceryl trinitrate, with little effect. The ECG shows an acute inferior myocardial infarction. The candidate is able to take history from and examine the patient. One of the faculty provides the voice of the patient via a remote microphone. The candidate may elect to prescribe a thrombolytic agent.

Various options available to the faculty in the scenario design may include a relative contraindication such as marked hypertension, hypotension following initiation of thrombolysis, ventricular tachycardia, etc. The faculty meanwhile observe the scenario from behind a one-way mirror. They have control over the parameters listed in table 1, depending on the type of simulator used. Two-way communication with a faculty ''plant'' within the scenario (the nurse) is achievable through headsets and microphone. This should enable the smooth running of the scenario.

Facilitated peer group feedback with or without the use of a video follows completion of the scenario. Peers will have observed the scenario either directly through a one-way mirror or through a video link. Points for consideration in analysis of candidate performance may include adherence to established protocols, clinical knowledge, communication skills and team leadership.

Medical emergencies

In January 2000, we secured funding for teaching emergency medicine trainees at the Bristol Medical Simulation Centre. We ran five study days in 2000 targeted at medical emergencies with themes as detailed in table 2. We used a Meti model (Human Patient Simulator System 5, Model C Manikin, Medical Education Technology Incorporated, Gainsville, Florida, USA) but were able to revisit some of the scenarios in 2002 with Laerdal SimMan (System 1, Laerdal Medical Limited, Orpington, Kent, UK). Each day consisted of four workshops and four scenarios. The trainees, supplemented by clinical fellows and staff grades, were divided into two groups of, typically, six. Each participant was sent precourse learning suggestions. Each of the specialist registrars had an opportunity to act as a candidate in one of the scenarios.

Abbreviations: ECG, electrocardiogram; SAVE, Scottish Airway and Ventilation Emergency

Table 1 Simulator capabilities

Simulator capabilities	Meti*	Laerdal SimMan
Airway		
Oral/nasal endotracheal intubation	✓	✓
Difficult airway	✓	✓
Trismus	×	✓
Decreased neck movement	✓	✓
Needle cricothyroidotomy	✓	✓
Surgical airway	✓	✓
Breathing		
Breath sounds (wheezes/crackles/absent)	✓	✓ (and stridor)
Tension pneumothorax	Left side only	Either side
Endobronchial intubation	✓	✓
Needle thoracocentesis	Left side	
Chest drain insertion	Right side	×
Respiratory rate variation	✓	✓
Bronchial tree	×	✓
Circulation		
Palpable pulses	Carotoid, fermoral, radial, brachial, dorsal pedal	Radial, carotid
Physiological response to drugs	✓	Not automatic
Defibrillation	✓	✓
Rhythm changes	✓	✓
Disability		
Pupil sizes and responses	✓	×
Eyes open or closed/blink speed	✓	×
Voice simulation	Via microphone	Inbuilt cough, moan, vomit or microphone
Instructor control		
ECG	✓	✓
Sats	✓	✓
NIBP	✓	✓
IBP	✓	×
CVP	✓	✓
$ETCO_2$	✓	✓

CVP, central venous pressure; ECG, electrocardiogram; $ETCO_2$, end-total carbon dioxide concentration in the expired air; IBP, invasive blood pressure; NIBP, non-invasive blood pressure.

Trainee evaluation was led by two of the trainees. Feedback from all 10 trainees who had attended simulator training was sought through a questionnaire. This was analysed, and the results have been presented nationally. Trainer evaluation was sought by oral and written feedback.

Rapid sequence induction

From 2001 we have run four Scottish Airway and Ventilation Emergency (SAVE) courses a year using the Meti model. SAVE essentially centres around six typical resuscitation room scenarios in which there is a need for rapid sequence induction. Medical and trauma scenarios are included. Feedback was again sought from trainees and trainers who we selected to put through the course.

RESULTS

Medical emergencies

The trainees believed that overall, the simulator offered valuable training experience. Using a purpose-built centre remote from the hospital environment enabled focused training without distraction. The structure of the day (alternating scenarios and workshops) was commended.

The advantages and disadvantages of the two types of simulators, as experienced by both trainers and trainees, are summarised in box 2. It is worth emphasising that the Meti simulator was prone to crashing. A complete crash required a tiresome wait while rebooting the control computer. A partial crash was also problematic. A sudden loss of the oxygen saturation facility might prompt the trainee into seeking facilitation from the nurse, seen to be wearing the headphones. By inadvertently reverting to typical advanced life-support course behaviour, the advantages of the remote facilitator Laerdal model was lost.

In general, the better-simulated scenarios with either model were those associated with cardiac arrest or coma or those with a cardiac theme. Scenarios were more realistic if every effort was made to recreate a resuscitation room rather than an anaesthetic room environment. In addition, having all participants in uniform added to the realism.

The training day required at least four trainers. Two were needed for each scenario, so that typically each trainer saw only half the scenarios and half the workshops. This limited the continuous professional development value of the day. Any trainees new to the simulator also needed an introduction (''normal'' breath sounds, its airway anatomy, etc). Some of the trainees found the simulated scenarios threatening despite attempts at empathetic facilitation. Finally, the trainers believed that the trainee's ''value'' of the education was not necessarily based on the high-level simulator, but rather on the effort that the trainers had put into preparing the day.

Rapid sequence induction

Overall, the feedback was highly positive and similar to that from trainers elsewhere.[2] Trauma scenarios could also be further enhanced by use of supplementary plastic make-up. The SimMan model can be exchanged for the Meti in this field—indeed, we had to do so when the Meti developed major problems. The scenarios benefited from its better airway and breathing features, and scenario control was easier. Its lack of eye features limited the realism of any simulated awake or semiconscious patient, however.

Table 2 Study-day composition

Study-day theme	Workshops	Scenarios
Beyond advanced life support	Complete heart block Hyperkalaemia Critical appraisal Hypothermia	Electrocution Near drowning/hypothermia Anaphylaxis Hyperkalaemia
Cardiac emergencies	Continuous positive airway pressure Electrocardiogram interpretation Rule out myocardial infarction strategies Objective structured clinical examination	Uncomplicated thrombolysis Atrial fibrillation Infero right ventricular infarct Anterolateral infarct complicated by cardiogenic shock
Respiratory emergencies	Asthma Pulmonary emboli COPD Objective structured clinical examination	Severe asthma Hypotensive patient? PE COPD with pneumothorax COPD with the use of bi-level positive airway pressure
Paediatric emergencies	Acute asthma Meningococcal sepsis Status epilepticus Objective structured clinical examination	Meningococcal sepsis Laryngotracheitis Acute asthma Status epilepticus
Coma	Fluid replacement Subarachnoid haemorrhage Tricyclic antidepressant overdose Hyponatraemia	Tricyclic antidepressant overdose Hyponatraemia Collapse/pneumonia? Subarachnoid haemorrhage

COPD, chronic obstructive pulmonary disease; PE, pulmonary embolus.

DISCUSSION

Other simulator roles in emergency medicine

Senior emergency department nurses from the Bristol Royal Infirmary, Bristol, UK, have successfully run national thrombolysis study days for emergency department nurses at the Bristol Medical Simulation Centre since 2000. One of us instructs on a course on transport of the critically ill patient, a potential role for the speciality. Emergency medicine crisis resource management courses have been run in North America[3] and Australia since 1998. The uncertainty, complexity and rapidly changing priorities of simultaneous patients in a resuscitation room are reproduced. The training has largely been based on aviation industry models. Leadership and team dynamics are explored. Laerdal SimMan's portability also gives trainers the option of simulating scenarios in the real rather than the virtual resuscitation room—for example, analysing trauma team performance. The Bristol Medical Simulation Centre also has the technology to enable satellite-linked educational conferencing so that other groups of trainees and trainers can observe scenarios and offer feedback.

Box 1 Advantages in simulated resuscitation

- There is no patient risk
- Errors can be allowed to occur
- The choice of scenario is not limited
- The patient's pathology is known to the instructor
- Identical scenarios can be presented to different candidates or teams
- Psychomotor skills can be assessed
- Interpersonal interactions with other professionals can be explored and training on teamwork, leadership and communication provided
- The simulated session may be recorded; there are no issues of patient confidentiality—the recordings can be used for research performance assessment or accreditation

Future improvements

Future improvements are eagerly awaited for both simulators described. A simulated colour change (pink/blue/pale) and beads of sweat over the forehead will surely add realism in many scenarios. Replication of its competitor's eye features will enable Laerdal to produce a hugely competitive model given its user-friendly interface, its better airway and breathing simulation, and its reliability, portability and comparable cost. However, the METI HPS system 6 incorporates a Macintosh

Box 2 Comparison between the Meti and Laerdal models

- SimMan has better airway features and considerably better breath sounds
- SimMan-simulated awake or semiconscious patients lack realism as eye opening, blinking and capillary responses are not a feature
- Considerable effort is required in learning how to control the Meti model. The Windows interface for SimMan is much easier
- Meti simulator is prone to crashing
- Neither model realistically simulates acute respiratory embarrassment or the evidently unwell patient

Box 3 Assessment definitions[4]

- *Summative assessment*: an assessment on which the trainee's future is to be made (the annual Record of In-Training Assessment (RITA) is a good example)
- *Formative assessment*: an assessment, which is for the benefit of the trainees in terms of guiding their further study (a mock examination, for example)

Box 4 Setting up scenario training using a high-level simulator

- Consider the Laerdal model
- Make an absolute commitment to recreating a virtual resuscitation room
- A one-way mirror is not essential—consider video or a goldfish bowl technique for the candidate's peers and a screen for the facilitators
- Ensure all ''props'' are at hand (electrocardiogram, blood gas results, *x* rays and equipment)
- Ensure all candidates have been introduced to the simulator and recognise normal airway features, breath sounds, for example
- Use a ''plant'' (acting senior nurse, for example) to enable smooth running of the scenario without acting as an obvious facilitator. Explain this to the candidate
- Consider linking the scenario with a workshop
- Make it clear to all candidates that any assessment is formative and not summative.

control system that, although slow to load, produces a more intuitive interface and allows several virtual patients to be run simultaneously. These software patients can be superimposed in turn on one or more manikins from a single wireless control computer. The new METI ''emergency care simulator'', on the other hand, trades some physical features such as realistic gas exchange for increased portability, and can function on its own battery supply for several hours in the back of an ambulance.

Future roles for high-level simulators

Are high-level simulators the emergency medicine clinical assessment tool of the future? Perhaps. Clearly, the same scenario can be reproduced, giving each candidate the same test. High-level simulator assessment is also likely to become more feasible as an increasing number of centres acquire them. More doctors are therefore likely to be exposed to teaching with these simulators, and therefore testing on a novelty manikin is less likely.

However, high-level simulation as an assessment tool scores poorly at present in terms of validity, particularly in comparison with direct observation of the critically ill patient. Their proposed improvements, as outlined, may enable more valid assessment in future.

CONCLUSION

High-level simulators have proved a valuable addition to specialist registrar training in emergency medicine in the south west. The Meti model is the more realistic, but is prone to technological problems. It also takes considerable effort in learning how to use it. The Laerdal model has better airway features and much better breath sounds. It is also simple to use. It is, however, limited by its eye features (upgrade awaited). The Meti model functions well for rapid-sequence induction training purposes. Although medical emergencies are not universally well created in either model, proposed technological improvements should enhance realism. Nevertheless, the remote facilitator-run scenario is possible if well prepared. Total engagement of the candidate in the scenario has been witnessed, enabling more realistic assessment of a trainee's performance. Their use in summative assessment (see box 3[4]) is likely in time. We encourage high-level simulator use as an educational tool in other regions, with the recommendations highlighted (box 4).

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